NASA and Orbital Reach Differing Conclusions on Antares Failure

Jeff Foust October 29, 2015

An Orbital Sciences Corp. Antares rocket exploded seconds after liftoff from Wallops Island, Virginia, Oct. 28. Credit: NASA

WASHINGTON — A NASA investigation into last year's failure of an Orbital ATK Antares launch vehicle identified three possible technical root causes of the accident, a conclusion consistent with, but not identical to, Orbital's own investigation.

An executive summary of a NASA Independent Review Team (IRT) report into the October 2014 loss of an Antares shortly after liftoff, released by NASA Oct. 29, concluded there was an explosion in the liquid oxygen turbopump in one of the two AJ-26 engines, designated E15, in the vehicle's

first stage about 15 seconds after ignition. The vehicle lost thrust and crashed to the ground near its launch pad.

The explosion was triggered when rotating and stationary components in part of the turbopump came into contact. “This frictional rubbing led to ignition and fire” in the turbopump, and thus the explosion, the report states.

The report, though, could not determine what cased the turbopump problem in the first place. “The IRT was not able to isolate a single technical root cause for the E15 fire and explosion,” the report states. Instead, investigators identified three potential root causes, “any one or a combination of which could have resulted in the E15 failure.”

One potential root cause was an “inadequate design robustness” of the engine. Investigators said the nature of the engine’s design made it susceptible to oxygen fires and failures similar to the one experienced on the Antares mission. Acceptance testing of the engines was not sufficient to detect those problems, according to the report.

A second potential root cause was foreign object debris, in the form of silica and titanium, found in the engine after the accident. Investigators concluded there were not “gross levels” of such debris in the engine, based on the lack of additional damage to the engine, but could not determine how much debris was in the engine prior to the explosion.

The final potential root cause was a manufacturing defect with the engine. Investigators found a defect in the engine similar to one found in another AJ-26 engine that exploded on a test stand at NASA’s Stennis Space Center during acceptance testing in May 2014. The report said it wasn’t clear that this defect alone would be sufficient to cause the explosion.

AJ-26 rocket engine being test fired. Credit: Aerojet Rocketdyne

That finding regarding technical root causes is different from the Orbital's own Accident Investigation Board. An executive summary of that report, submitted to the Federal Aviation Administration and obtained by SpaceNews, agreed with NASA's conclusion that elements of the turbopump came into contact and ignited the fire that caused the explosion.

The Orbital report, though, identified a single "highly probable" technical root cause of the failure: a machining defect in turbine assembly of the turbopump that dates back to when the engine was manufactured in the former Soviet Union more than 40 years ago. An adjacent piece of the engine, recovered with little damage after the explosion, showed a "clear defect" in its machining, according to the report.

Orbital's report also identified several other technical root causes it deemed "credible" but less likely to have caused the explosion. Those additional causes included other technical problems with the engine and "poor long-term storage" of the engine, causing corrosion of engine components.

Foreign object debris, one of the leading root causes of the NASA investigation, was considered "possible but unlikely" in the Orbital report.

"No credible opportunities for contamination were found," it stated. The Orbital report did not address the "design robustness" issue identified as a potential root cause by NASA.

The dismissal of foreign object debris by Orbital puts it at odds with Aerojet Rocketdyne, who suggested earlier this year that such debris contributed to the failure. Aerojet announced Sept. 24 it would pay Orbital $50 million to end the dispute between the companies about the accident.

Aerojet Rocketdyne spokesman Glenn Mahone did not respond to a request for comment late Oct. 29 about the accident investigation reports. However, he said Sept. 25 that there was little he could publicly discuss about Aerojet's own investigation into the accident, citing proprietary data.

The NASA report also found that both Aerojet and Orbital lacked sufficient information of the AJ-26 engine, including "failure history knowledge" dating back to its Soviet origins. "A lack of design and operating insight into the AJ-26 engines creates a low level of confidence in loss-of-mission predictions made by Orbital ATK and Aerojet Rocketdyne," the report stated.

The report added that there were some issues in how NASA and Orbital understood and communicated risk as part of its Commercial Resupply Services (CRS) contract, which the failed Antares launch was part of. However, investigators concluded that "that the CRS model is generally working as intended."

Orbital has since moved on from the AJ-26 engine that caused the Antares failure, replacing it with the Russian RD-181 engine. A static fire test of the first Antares equipped with RD-181 engines is scheduled for early 2016, with launch tentatively planned for May.